

CCR Number: 0042

CRITICALITY: ROUTINE

DUE: 1/10/00

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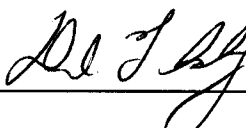
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NEW MILLENNIUM PROJECT CONFIGURATION CHANGE REQUEST

PROGRAM <u>EO-1</u> CCR NO. 0042 DATE INITIATED 12/21/1999	TITLE CHANGES TO EO-1 TRW/GSFC INTERFACE DOCUMENT ORIGINATOR Nick Speciale ORIGINATOR'S CHG. NO. SPONSOR/CODE Nick Speciale/426 PHONE x8704																													
EFFECTIVITY ITEM: <u>EO-1</u> S / N _____ ITEM: _____ S / N _____ ITEM: _____ S / N _____	CHANGE CLASS <table style="width:100%;"> <tr> <td></td> <td align="center">I</td> <td align="center">II</td> </tr> <tr> <td>PRELIMINARY</td> <td align="center"><input type="checkbox"/></td> <td align="center"><input type="checkbox"/></td> </tr> <tr> <td>FORMAL</td> <td align="center"><input type="checkbox"/></td> <td align="center"><input type="checkbox"/></td> </tr> </table>		I	II	PRELIMINARY	<input type="checkbox"/>	<input type="checkbox"/>	FORMAL	<input type="checkbox"/>	<input type="checkbox"/>	TYPE OF CHANGE <table style="width:100%;"> <tr> <td>MILESTONE</td> <td align="center"><input type="checkbox"/></td> <td>INTERFACE</td> <td align="center"><input type="checkbox"/></td> <td>SOFTWARE</td> <td align="center"><input type="checkbox"/></td> </tr> <tr> <td>DOCUMENT</td> <td align="center"><input checked="" type="checkbox"/></td> <td>POWER</td> <td align="center"><input type="checkbox"/></td> <td>OTHER</td> <td align="center"><input type="checkbox"/></td> </tr> <tr> <td>COST</td> <td align="center"><input type="checkbox"/></td> <td>WEIGHT</td> <td align="center"><input type="checkbox"/></td> <td></td> <td align="center"><input type="checkbox"/></td> </tr> </table>		MILESTONE	<input type="checkbox"/>	INTERFACE	<input type="checkbox"/>	SOFTWARE	<input type="checkbox"/>	DOCUMENT	<input checked="" type="checkbox"/>	POWER	<input type="checkbox"/>	OTHER	<input type="checkbox"/>	COST	<input type="checkbox"/>	WEIGHT	<input type="checkbox"/>		<input type="checkbox"/>
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DOCUMENTS OR SOFTWARE AFFECTED EO-1 TRW/GSFC INTERFACE DOCUMENT																														
PROBLEM The attached Preliminary Interface Revision Notice (PIRN) contains changes to the EO-1 TRW/GSFC Interface Document. Approval of these changes will authorize the formal incorporation into the baselined document.																														
PROPOSED SOLUTION Approve the attached PIRN 001 to EO-1 TRW/GSFC Interface Control Document (ICD) by the EO-1 Level II Configuration Control Board (CCB). The signed CCR will officially authorize the incorporation of changes into the document by EO-1 Project Management. Future changes will be initiated by submittal of Configuration Change Requests (CCRs) and PIRNs. This document is maintained by EO-1 Configuration Management Office.																														
BOARD ACTION APPROVE <input checked="" type="checkbox"/> APPROVE WITH CHANGE <input type="checkbox"/> DISAPPROVE <input type="checkbox"/> WITHDRAW <input type="checkbox"/>	APPROVAL LEVEL REQUIRED LEVEL I HQS <input type="checkbox"/> LEVEL II GSFC <input checked="" type="checkbox"/> LEVEL III <input type="checkbox"/>	CRITICALITY LEVEL EMERGENCY <input type="checkbox"/> URGENT <input type="checkbox"/> ROUTINE <input checked="" type="checkbox"/>	PROCUREMENT CHANGE ORDER CLASSIFICATION <table style="width:100%;"> <tr> <td>ROUTINE</td> <td>URGENT</td> <td>EMERGENCY</td> </tr> <tr> <td>OPTION 1 <input type="checkbox"/></td> <td>OPTION 1 <input type="checkbox"/></td> <td></td> </tr> <tr> <td>OPTION 2 <input type="checkbox"/></td> <td>OPTION 2 <input type="checkbox"/></td> <td></td> </tr> </table>	ROUTINE	URGENT	EMERGENCY	OPTION 1 <input type="checkbox"/>	OPTION 1 <input type="checkbox"/>		OPTION 2 <input type="checkbox"/>	OPTION 2 <input type="checkbox"/>																			
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COMMENTS <div style="text-align: center; font-family: cursive; font-size: 1.2em;"> Approve to incorporate PIRN 001 into ICD-04 TRW/GSFC ICD. </div> <div style="display: flex; justify-content: space-between; margin-top: 20px;"> <div style="text-align: center;"> CHAIRPERSON </div> <div style="text-align: center;"> DATE 4/28/00 </div> </div>																														

GODDARD SPACE FLIGHT CENTER		1. PAGE 1 OF 21	
PRELIMINARY REQUIREMENTS CHANGE NOTICE (PSCN) No. <u>001</u>		2. INIT. DATE: 12/21/99	
or		3. CONTRACT NUMBER	
PRELIMINARY INTERFACE REVISION NOTICE (PIRN) No. _____			
4. ASSOCIATED CONTROL NUMBERS: EO-1CCR 0042	5. CI'S AFFECTED: TRW/GSFC INTERFACE DOCUMENT	6. DOCUMENT NUMBER: REVISION:	
7. DESCRIPTION OF CHANGE:			
1. <u>Add</u> : The following section (s) to TRW/GSFC ICD. (See attached)			
PREPARED BY: S. Schneider/EO-1 CMO		ORIGINATING ORGANIZATION APPROVAL:	ORGANIZATION: DATE:
HST CCB ACTION		SIGNATURE:	DATE: 4/28/00
APPROVED: <input checked="" type="checkbox"/> DISAPPROVED:			MINUTES No:

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3.3.1 Hyperion Level 1 Data Set Transfer

This section of the “EO-1 Project TRW/GSFC Data Interface Control Document” covers data interfaces between TRW and Goddard Space Flight Center (GSFC) supporting Level 1 data processing.

Level 1 (L1) processing uses Level 0 (L0)-processed data received from GSFC via electronic or DLT 7000 tape to produce radiometrically-corrected images, as shown schematically in Figure 3.3.1-1. Ground image, solar calibration and lunar calibration data are processed identically. Level 0 SWIR data is corrected for echo and smear prior to any Level 1 processing. Level 0 dark files are averaged over the number of frames collected and subtracted from image files and from similarly averaged white files. Gain coefficients are calculated by dividing the white cal file (after dark subtraction) into the pre-flight or laboratory white file. Each image pixel is multiplied by the corresponding gain coefficient to obtain the final radiometrically corrected Level 1 image data. Logfiles are produced by the Level 1 processing code to provide a record of the processing steps. These files are added to the Level 1 data, along with GSFC-produced metadata and ancillary data files, and written out on a DLT tape for shipping to GSFC.

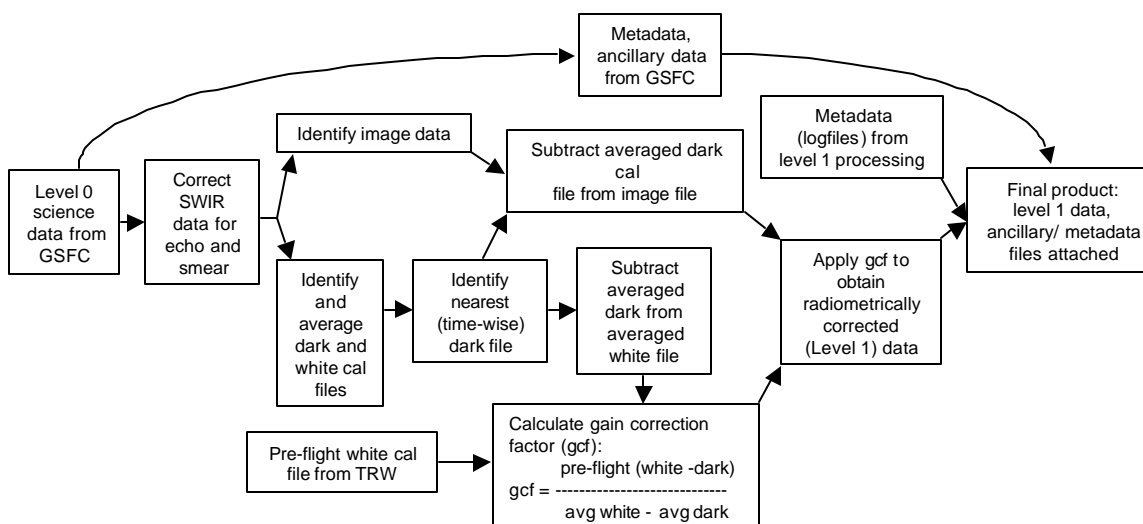


Figure 3.3.1-1 Level 1 Processing Flow

The Level 1 data file consists of radiometrically corrected images formatted as HDF files, metadata in binary and ASCII formats, and ancillary data. The Level 1 data set is defined in Table 3.3.1-1. Level 1 file names were chosen to indicate their origin within the Level 1 processing flow. The .L1 appendage is reserved for the final, fully processed Level 1 output. The logfiles are labeled with the image file name followed by .log. The “_rX” in the file name is a revision number that allows for re-calibration.

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Table 3.3.1-1 Level 1 Data Set Files

Level 1 Data Set Files	File Name	Data File Description and Format	Originator
Level 1 processed data	EO1XXXXXXXXXXXXXXXXXX_rX.L1	Fully processed Level 1 DCE (Data Collection Event) HDF	TRW L1 processing
Metadata File #1	File names: TBD (Pass through file from GSFC)	Image-specific metadata including: Scene request file, Event report file, DCE ground system status report, Level 0 quality report Text file	GSFC
Metadata File #2	HYP_PREFLIGHT_RX.txt	Summary of pre-flight instrument characterization Text file (MS Word)	TRW
Metadata File #3	EO1XXXXXXXXXXXXXXXXXX_rX.cal.log	Level 1 calibration logfile Text file	TRW L1 processing
Metadata File #4	EO1XXXXXXXXXXXXXXXXXX_rX.avg	Averaged dark current file (averaged over no. of dark frames acquired) Binary, band sequential (BSQ) order	TRW L1 processing
Metadata File #5	EO1XXXXXXXXXXXXXXXXXX_rX.avg	Averaged white file (averaged over no. of white frames acquired) Binary, BSQ	TRW L1 processing
Metadata File #6	EO1XXXXXXXXXXXXXXXXXX_rX.avg.log	Averaged dark logfile Text file	TRW L1 processing
Metadata File #7	EO1XXXXXXXXXXXXXXXXXX_rX.avg.log	Averaged white logfile Text file	TRW L1 processing
Metadata File #8	EO1XXXXXXXXXXXXXXXXXX_rX.gain	Calibration coefficients Binary,BSQ	TRW L1 processing
Metadata File #9	EO1XXXXXXXXXXXXXXXXXX_rX.echo.log	Echo removal logfile Text file	TRW L1 processing
Metadata File #10	EO1XXXXXXXXXXXXXXXXXX_rX.smear.log	Smear detection logfile Text file	TRW L1 processing
Metadata File #11	EO1XXXXXXXXXXXXXXXXXX_rX.sqa	Scene Quality Assessment Text file (MS Word)	TRW L1 processing
Metadata File #12	File names: see Sec. 4.3	Flight Dynamics Products (Sec 4.3)	GSFC/FDSS
Ancillary Data	File names: acs_hdf_vc3_yy-ddd-hh-mm.hdf ali_hdf_vc3_yy-ddd-hh-mm.hdf eff_hdf_vc3_yy-ddd-hh-mm.hdf gps_hdf_vc3_yy-ddd-hh-mm.hdf hyp_hdf_vc3_yy-ddd-hh-mm.hdf lac_hdf_vc3_yy-ddd-hh-mm.hdf misc_hdf_vc3_yy-ddd-hh-mm.hdf w_hdf_vc3_yy-ddd-hh-mm.hdf w_hdf_vc3_yy-ddd-hh-mm.hdf xbnd_hdf_vc3_yy-ddd-hh-mm.hdf xbnd_hdf_vc3_yy-ddd-hh-mm.hdf (Pass through files from GSFC)	DCE SOH (State of Health) telemetry files (see Sec. 4.2)	GSFC/MOC

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Level 1 data is transferred along with metadata and ancillary data from TRW to SVF during normal operations (Interface S4, Figure 3.3.1-2). TRW will mail a DLT 7000 tape with a TAR file containing Level 1 image data, metadata and ancillary data received from GSFC, metadata generated by TRW and a qualitative assessment based on a spot-check of a portion (660 frames) of a Level 1 image, with a goal of shipping within 3 business days of receipt of request and receipt of the associated Level 0 tape, metadata and ancillary data from the SVF. The Level 1 tapes will be sent to NASA/GSFC, Code 923, Greenbelt, MD, 20771-0001.

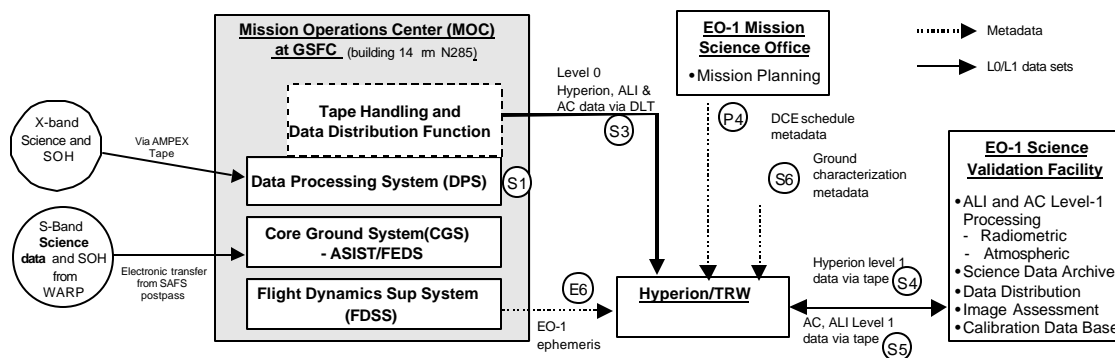


Figure 3.3.1-2 Hyperion Science Data Flow, Normal Operations

3.3.1.1 Metadata

Metadata files are binary or ASCII text files. Table 3.3.1.1-1 summarizes the metadata, which consists of unchanging data generated by TRW in support of Level 1 processing, and image specific or periodically changing data received from GSFC as well as generated by TRW. The averaged dark current file (metadata file (MD)#4) contains one frame of binary data in the same byte order and data type as the Level 0 image (big-endian and 16-bit unsigned integer) without header or footer. Image pixel order is band-interleaved (BIL) whereas, due to averaging over the number of frames acquired, averaged dark and white files have band sequential order (BSQ). For a single frame, BSQ and BIL are identical; the averaged files are listed as BSQ in the level 1 logfile to clearly differentiate them from the image files, which are not averaged. The calibration coefficients file (MD#8) is in the same format but contains 32-bit floating-point values. The GSFC-supplied metadata files will be delivered on the same tape as their associated Level 0 data, and contain embedded timecodes that enable them to be matched to DCE files. The GSFC-supplied metadata will not be altered in any way during Level 1 processing. It will be copied from the L0 tape onto the L1 tape.

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Table 3.3.1.1-1 Description of Metadata Contents

File #	Items Which Change Infrequently	Image Specific Items or Items with Periodic Changes
MD#1	Program POC	File creation date Software version number Instrument status (on/off) File size Scene Request File Event Report File Ground and underflight (e.g., AVIRIS) Characterization of vicarious calibration sites (S6) Identification of Landsat7 image pair (P4) Filenames of ALI and AC comparison files Filenames of ancillary data files Requested Location of Image (lat/long) Start/ Stop time of data Sun azimuth and elevation Pointing information Calibration Flags Gains and Offsets Quality information Ground station ID# Ground station status report Ground station contact start/stop time
MD#2	Pre-flight instrument characterization data Modulation transfer function Spectral calibration Spectral response profile Cross-track spectral error Spatial co-registration of spectral channels Radiometric calibration Polarization sensitivity	
MD#3		Level 1 calibration logfile (see sample below)
MD#4		Averaged dark current file
MD#5		Averaged white file
MD#6		Averaged dark current logfile (see sample below)
MD#7		Averaged white logfile (see sample below)
MD#8		Calibration coefficients
MD#9		Echo correction logfile Existence of logfile indicates image was corrected for echo
MD#10		Smear correction logfile Existence of logfile indicates image was corrected for smear
MD#11		Image Quality Spot Check Filename No. of frames assessed Operational sensors (VNIR and/or SWIR) Existence of streaking, banding, shading, saturation, focus problems, linedrops Cloud cover Averaged dark and white file values
MD#12		Flight Dynamics Products (see Sec 4.3))

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The Level 1 logfile, E01XXXXXXXX_XXXXXXXX_rX.cal.log, (MD#3) has the following format. The source and output files have band interleaved (BIL) pixel order. The dark, lab white, and white calibration files have been averaged over the number of frames taken of each to produce a single averaged frame. Averaging is indicated by the pixel order being listed as band sequential (BSQ). The log begins and ends with asterisks. The top section lists the command name, the Hyperspectral Image Processing (HIP) version number, and processing date. Each section is marked with five dashes and ends with a blank line, and there are sections describing command line arguments and input and output files.

```
***** cubecal *****
HIP 1.0
Wed Sep 15 15:04:43 1999

----- Arguments -----
--source-file=/dra2/archive/level0/ground/E01yyyyddd_XXXXXXXX_r1.L0
--output-file=/dra2/archive/level1/ground/E01yyyyddd_XXXXXXXX_r1.L1
--darkcal-file=/dra2/archive/level1/ground/E01yyyyddd_XXXXXXXX_r1.avg
--whitecal-file=/dra2/archive/level1/ground/E01yyyyddd_XXXXXXXX_r1.avg
--labwhite-file=/dra2/calfiles/hyp242x256
--labwhite-data=float32
--cal-multiplier=100
--check-dead
--verbose

----- Source file -----
File name: /dra2/archive/level0/ground/E01yyyyddd_XXXXXXXX_r1.L0
Type:      Hyperion
Dimensions: 256 pixels x 242 bands x 660 frames
Data type: 16-bit unsigned integer
Byte order: big
Pixel order:      BIL

----- Output file -----
File name: /dra2/archive/level1/ground/E01yyyyddd_XXXXXXXX_r1.L1
Type:      Hyperion
Dimensions: 256 pixels x 242 bands x 660 frames
Data type: 16-bit unsigned integer
Byte order: big
Pixel order:      BIL
Source:           /dra2/archive/level0/ground/E01yyyyddd_XXXXXXXX_r1.L0

----- Lab white file -----
File name: /dra2/calfiles/hyp242x256
Type:      Generic
Dimensions: 256 pixels x 242 bands x 1 frames
Data type: 32-bit floating point
Byte order: big
Pixel order:      BSQ

----- White cal file -----
File name: /dra2/archive/level1/ground/E01yyyyddd_XXXXXXXX_r1.avg
Type:      Generic
Dimensions: 256 pixels x 242 bands x 1 frames
```


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Data type: 16-bit unsigned integer
 Byte order: big
 Pixel order: BSQ

----- Dark cal file -----

File name: /dra2/archive/level1/ground/E01yyyyddd_xxxxxxxx_r1.avg
 Type: Generic
 Dimensions: 256 pixels x 242 bands x 1 frames
 Data type: 16-bit unsigned integer
 Byte order: big
 Pixel order: BSQ

----- Calibration options -----

Multiplier: 100

----- Result -----

Dead pixel: band 190 sample 103

----- Summary -----

27630592 pixels calibrated
 1 dead pixels (0.00161415%)

The average dark logfile, E01XXXXXXXX_XXXXXXXX_rX.avg.log (MD#6), has the following format. Note that the output file in MD#7 and MD#8 (below) are listed as having BIL pixel order rather than BSQ as shown in MD#3; BSQ and BIL are identical for a file with a single frame of data.

***** cubeavg *****

HIP 1.0

Mon Oct 11 16:31:08 1999

----- Arguments -----

--source-file=/dra2/archive/level0/ground/E01yyyyddd_xxxxxxxx_r1.L0
 --output-file=/dra2/archive/level1/ground/E01yyyyddd_xxxxxxxx_r1.avg
 --output-type=generic
 --verbose

----- Source file -----

File name: /dra2/archive/level0/ground/E01yyyyddd_xxxxxxxx_r1.L0
 Type: Hyperion
 Dimensions: 256 pixels x 242 bands x 220 frames
 Data type: 16-bit unsigned integer
 Byte order: big
 Pixel order: BIL

----- Output file -----

File name: /dra2/archive/level1/ground/E01yyyyddd_xxxxxxxx_r1.avg
 Type: Generic
 Dimensions: 256 pixels x 242 bands x 1 frames
 Data type: 16-bit unsigned integer
 Byte order: big
 Pixel order: BIL
 Source: /dra2/archive/level0/ground/E01yyyyddd_xxxxxxxx_r1.L0

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----- Summary -----

Average: 445.908

The average white logfile, EO1XXXXXXXX_XXXXXXXX_rX.avg.log (MD#7), has the following format:

***** cubeavg *****

HIP 1.0

Mon Oct 11 16:31:23 1999

----- Arguments -----

--source-file=/dra2/archive/level0/ground/EO1yyyyddd_XXXXXXXX_r1.L0

--output-file=/dra2/archive/level1/ground/EO1yyyyddd_XXXXXXXX_r1.avg

--output-type=generic

--verbose

----- Source file -----

File name: /dra2/archive/level0/ground/EO1yyyyddd_XXXXXXXX_r1.L0

Type: Hyperion

Dimensions: 256 pixels x 242 bands x 670 frames

Data type: 16-bit unsigned integer

Byte order: big

Pixel order: BIL

----- Output file -----

File name: /dra2/archive/level1/ground/EO1yyyyddd_XXXXXXXX_r1.avg

Type: Generic

Dimensions: 256 pixels x 242 bands x 1 frames

Data type: 16-bit unsigned integer

Byte order: big

Pixel order: BIL

Source: /dra2/archive/level0/ground/EO1yyyyddd_XXXXXXXX_r1.L0

----- Summary -----

Average: 611.395

3.3.1.2 Ancillary Data

Ancillary data received on the Level 0 DLT from GSFC will be retransmitted with Level 1 data in the format received from the DPS. These ancillary data are a subset of spacecraft and instrument telemetry that provide a history of selected SOH parameters during the related DCE. The contents of the ancillary data file are summarized in Section 4.2. The GSFC-supplied ancillary data files will be delivered on the same tape as their associated Level 0 data, and contain embedded timecodes that enable them to be matched to DCE files. The GSFC-supplied ancillary data will not be altered in any way during Level 1 processing. It will be copied from the L0 tape onto the L1 tape.

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3.3.1.3 Calibration Files

Calibration files are of two varieties: solar/lunar/vicarious calibration information, which will look just like image data, and dark and white calibration data. The dark and white calibration data normally consist of 220 frames (1 sec) of dark calibration files, and 400 - 600 frames (2-3 sec) of lamp calibration data. Dark and white calibration files are acquired with every data collection event, including solar, lunar and vicarious calibrations.

The Level 1 code uses the dark and white calibration files nearest, time-wise, to the image for Level 1 processing. Level 1 processing requires that each frame of the white and dark files have the same pixel (spatial) and band dimensions as the images. The current white and dark files are separately averaged into single frames. The averaged dark file is available as MD #4. The average dark file is subtracted as background and the average white file is used to adjust the pre-flight white calibration file. New gain coefficients are derived and used to radiometrically correct the Level 0 data to Level 1. Gain coefficients are saved as a binary file in MD #8.

Solar, lunar and vicarious calibrations are processed through “normal” Level 1 processing as any other data collection event. Solar calibration files (L0) will be archived at the SVF for the duration of the mission so that any degradation, e.g., of the white paint on the Hyperion cover, may be traced over time. Lunar and vicarious calibration files will also be archived (L0) at the SVF for the duration of the mission for future reference.

3.3.1.4 Image Data

The Level 1 data will consist of a DCE composed of up to nine radiometrically corrected image cubes in HDF format. Each image cube contains 256 pixels, 220 bands of VNIR and SWIR (combined in Level 0 processing), and 660 frames. The instrument is specified as producing images in 220 spectral bands over the spectral range of 0.4 – 2.5 μm . The instrument actually has 242 spectral bands, which includes 6 buffer bands on either side of the SWIR and 5 buffer bands on either side of the VNIR to allow for alignment. Requests for Level 1 data will be on a per DCE basis, specified by Hyperion Level Zero Processing (HLZP) output file name, and sent to TRW by the SVF with the corresponding Level 0 data tape. Solar and lunar calibration files are processed in the same way as image files. Solar calibration image data will normally consist of approximately 2000 frames (~3 cubes). Lunar calibration files image data will normally consist of ~4600 frames (~7 cubes). The dimensions of the files are reported in MD#3.

3.3.1.5 Echo and Smear Removal (SWIR only)

The Level 0 data are first corrected for smear. A description of smear and the algorithms used to correct for smear can be found in TRW IOC HYPER-600-99-016. An intermediate smear corrected image file is not written out, although logfile MD#10 indicates that the correction has been completed.

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An electronic echo is also found in the Hyperion SWIR focal plane. Its effect can be mitigated through data processing using algorithms described in TRW IOC HYPER-300-99-008, "Summary of Hyperion SWIR Image Echo" 30 July 1999. Again, the logfile created in this process is MD#9, although an intermediate echo-corrected image file is not written out. Echo correction is performed on Level 0 data prior to radiometric correction. The echo correction process assumes 172 bands (160 bands plus 12 buffer bands) of SWIR data in the Level 0 file.

3.3.1.6 Image Quality Assessment

Image quality assessment is a qualitative assessment performed as a spot check on a single cube parsed from a requested DCE and reported using the following form, Figure 3.3.1.6-1. This form is a text file (MD#11) and will be supplied as hardcopy with the Level 1 tape. The form indicates the presence or absence of streaking, banding, shading, saturation, focus problems, and linedrops and provides an assessment of percent cloud cover as being <10%, <30% or >30%. The averaged dark and white file values are reported from the logfiles associated with the dark and white calibration files used in Level 1 processing of the image. Image quality assessments will be provided to the Mission Planning Office for SVF-requested science scenes (P5) along with the Level 1 data.

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Hyperion Level 1 Image Quality Assessment Form				
Filename	<u>EO1yyyddd_xxxxxxx_r1_cal.L1</u>			
Frames Assessed	<u>1-660</u>			
L0 Tape ID	<u>EO1XXX</u>			
GSFC-provided Metadata files included on tape?	<u>Yes</u>			
GSFC-provided Ancillary files included on tape?	<u>Yes</u>			
TRW-produced Metadata files included on tape?	<u>Yes</u>			
Sensors operational (Y/N): VNIR	<u>X</u>	SWIR	<u>X</u>	
1.0 Image Quality Check (✓ if present)				
	VNIR	SWIR	Comments	
1.1	<u>Streaking</u>			
1.2	<u>Banding</u>	<u>✓</u>	<u>Band 40-44</u>	
1.3	<u>Shading across FOV</u>	<u>✓</u>		
1.4	<u>Saturation</u>			
1.5	<u>Focus</u>			
1.6	<u>Linedrops</u>			
1.7	<u>% Cloud Cover</u>	<u>✓</u>	<u><10%</u>	<u><30%</u> <u>>30%</u>
2.0 Radiometric Calibration				
2.1	Averaged Dark File Value	<u>422.636</u>		
2.1	Averaged White File Value	<u>588.865</u>		
3.0 Additional Comments				

Figure 3.3.1.6-1 Hyperion Quality Assessment Form